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(54) Fluid filled elastomeric damping device

(57) A fluid filled engine mount for absorbing shock and dampening structural agitation is provided in which an elastomeric diaphragm 46 and an associated air chamber 40, 42 cooperate with a fluid filled chamber 26, 28 to allow high frequency, low amplitude structural agitation to the mount to occur with very little pressure developing in the fluid chambers and, accordingly, a slight damping response. The fluid chambers 26, 28 are included within an elastomeric shear spring 16 spacing a rigid outer housing 48 including the diaphragm 46 and air chamber 40, 42 from a rigid inner member 14. The housing and inner rigid member are typically associated with an engine frame and engine, respectively. The diaphragm is restrained against excessive deflection by the outer sleeve 48 which comprises a restraint stop for the diaphragm. Upon contact of the diaphragm to the outer sleeve, pressure is developed quickly in the fluid chambers which then activates either a tuned fluid resonance channel or, as shown, a restrictive fluid flow path 30 for dampening of the agitation.

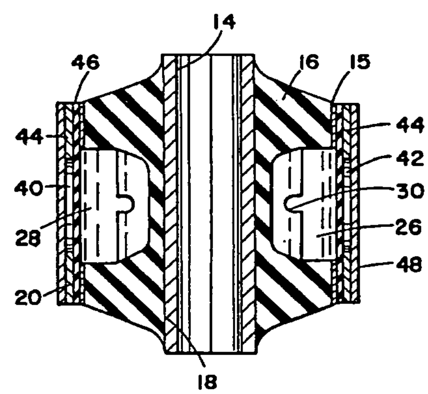
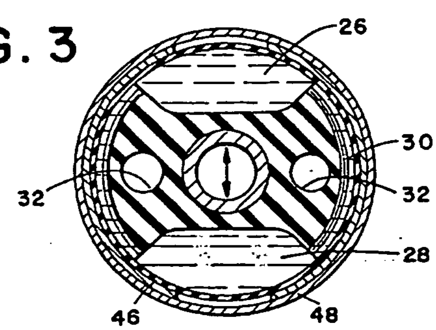


FIG. 2

FIG. 3



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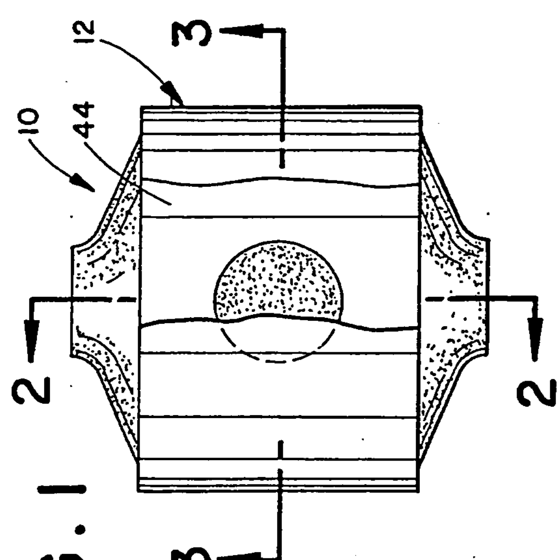

FIG. 1

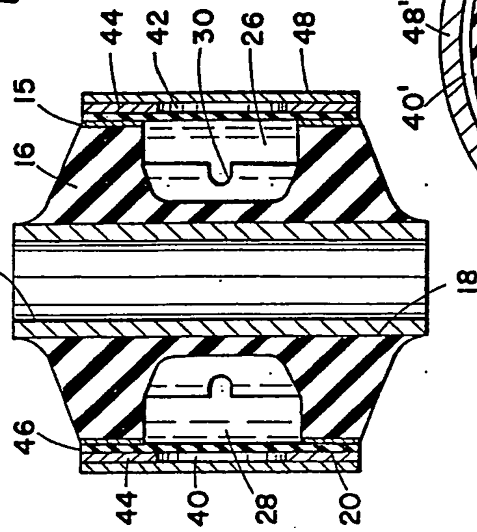

FIG. 2

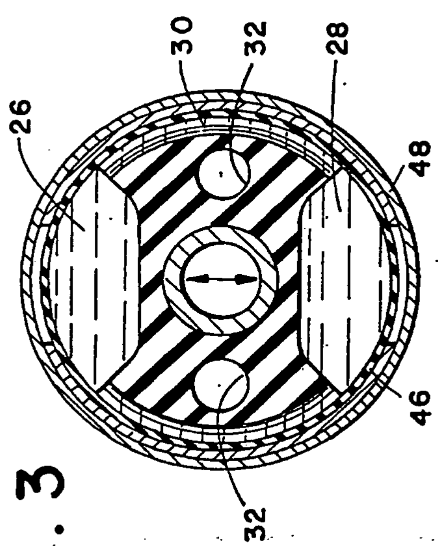

FIG. 3

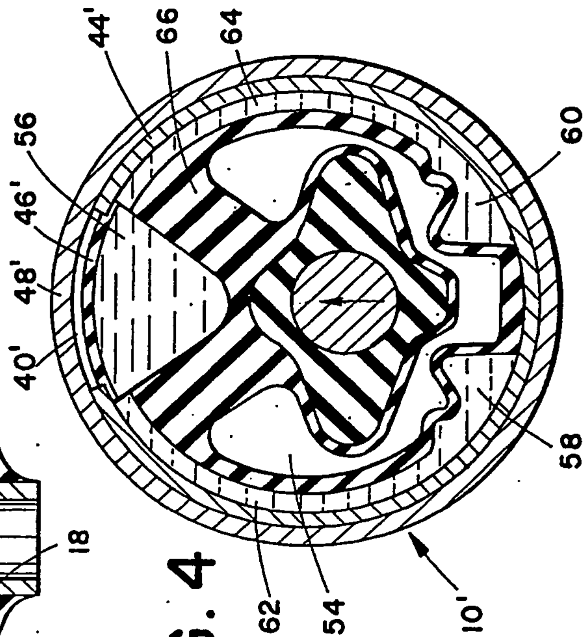

FIG. 4

SPECIFICATION

Fluid fill d elastomeric damping devic

Background of the Invention

This invention relates generally to fluid filled elastomeric damping devices and more particularly relates to a fluid damped device of the type which is mounted to vehicles and which uses both an elastomeric spring and flow of fluid for absorbing shock, structural leveling and energy dissipation.

It has been a constant problem to control and/or eliminate vibration and noise in automotive vehicles, while continuously improving the ride and comfort. Conventional spring dampers or elastomeric-hydraulic mounts typically have employed a housing having an elastomeric spring in the housing disposed to provide a loadcarrying capacity for the damper. Actuation of the flow of fluid is accomplished by stressing the elastomeric spring.

It is well known that for best performance, in a fluid engine mount, damping should be at a maximum at the natural frequency of the mount system. For large vibration amplitudes in the order of plus or minus 0.5 mm or greater, good performance is obtained when phase angles of twenty-five degrees or more occur at the resonant frequency. However, for small amplitudes, in the order of plus or minus 0.1 mm or less, damping is not desired as an associated high dynamic spring rate will occur. Various schemes have addressed this problem with some success. Many of the schemes are based on moving a partition of some material to permit limited free motion between two fluid filled chambers.

One attempt has been the use of a fluid filled elastomeric bushing as described in U.S. Patent 3,698,703 assigned to the General Tire & Rubber Company. This type of device, however, when subjected to high frequency vibrations would have high dynamic spring rates and thus poor high frequency performance. Various other devices have tried to address high frequency performance problems by using two liquid fluid chambers in which a partition member permits only limited free fluid motion between the two fluid filled chambers. These devices are designed so that the damping should be at a maximum at the natural frequency of the mount system. These devices, although generally effective, are complex in design, involving moving parts with associated high cost and reliability problems. Examples of such devices are U.S. Patent 4,159,091, to Le Salver and British Patent Application No. 8517885 (Serial No. 2 165 617).

The present invention contemplates a new and improved suspension member for loadcarrying and selectively varying damping response to structural agitation which overcomes the problems recited above.

The subject suspension device is simple in design, economical to manufacture, readily adaptable to a plurality of suspension and mounting member uses with items having a variety of dimensional characteristics and operating vibrations and which provides improved load carrying suspension with improved shock absorption and energy dissipation.

Brief Description of the Invention

Generally, the present invention contemplates a new and improved fluid filled engine mount for decoupling the high frequency, low amplitude dynamic properties of the mount to improve high frequency performance. The device allows small movements of the mount, which are associated with high frequency vibration, without incurring damping or high dynamic spring rates. The device includes a rigid outer housing and a rigid inner member which are associated with the vehicle frame and engine, respectively. An elastomeric shear spring spaces the housing from the inner member and includes a fluid-containing chamber with a restricted fluid flow path. A pressure relief means is associated with the fluid chamber to decouple the dynamic properties produced by small movements of the mount such as are normally associated with high frequency vibration. The pressure relief means preferably comprises a restrained elastomeric diaphragm in association with a recess providing an air chamber in the wall of the outer housing. During small movements of the mount, the elastomeric diaphragm deforms to relieve the pressure in the fluid chamber as opposed to deforming the shear spring or inducing fluid flow through the restricted flow path.

In accordance with another aspect of the present invention, the pressure relief means comprises an elastomeric coating and a rigid outer sleeve sandwiching an annular recess in the housing side wall portion. The sleeve restrains the diaphragm from excess radially outwardly directed deformation upon compression of the mount.

In accordance with another aspect of the present invention, opposed pressure relief means are employed adjacent opposed fluid containing chambers in communication through the restricted flow path.

The principal object of the invention is the provision of a fluid filled engine mount including a decoupling feature for decoupling high frequency structural agitation from normal mount spring and damping structural components for improved high frequency performance of the mount.

Another object of the present invention is the provision of an engine mount that offers good operational damping at the natural frequency of the mount system for low frequency, high amplitude structural agitation, while avoiding damping and consequently, a high dynamic spring rate, for high frequency,

low amplitude structural agitation.

Still other objects and advantages of the invention will become apparent to those skilled in the art upon a reading and understanding of the following specification.

Brief Description of the Drawings

The invention may take physical form in certain parts and arrangements of parts, a preferred and alternative embodiment of which will be described in detail in this specification and illustrated in the accompanying drawings which form a part hereof and wherein:

FIGURE 1 is an elevation view in partial section of an engine mount formed in accordance with the present invention;

FIGURE 2 is a cross-sectional view of the mount taken along lines 2-2 of FIGURE 1;

FIGURE 3 is a cross-sectional view taken along lines 3-3 of FIGURE 1; and,

FIGURE 4 is a cross-sectional view illustrating an alternative embodiment of an engine mount formed in accordance with the present invention.

Detailed Description of the Preferred Embodiment

Referring now to the drawings wherein the showings are for purposes of illustrating the preferred embodiments of the invention only and not for purposes of limiting same, the FIGURES show a fluid filled elastomeric damping device particularly configured for use as an engine mount. With particular reference to FIGURES 1 through 3, the device 10 includes a rigid outer housing 12 and a rigid inner member or sleeve 14 for association with an engine and an engine frame (not shown), respectively. The outer housing 12 and inner sleeve 14 are generally annular in cross-sectional configuration which is a conventional configuration for engine mount devices or support bushings. An elastomeric shear spring 16 spaces the inner sleeve 14 from the outer housing 12 and is bonded to the inner sleeve at a sleeve engaging wall 18 and is bonded to the housing at a housing engaging wall 20. An outer support ring 15 (See FIG. 2) may be used for bonding the outer portion of shear spring 16 instead of directly bonding it to engaging wall 20. The bond is achieved with conventional chemical bonding techniques.

The shear spring 16 includes first and second fluid chambers 26, 28 which are in fluid communication through a peripheral restricted flow path 30 for shock dampening upon deformation of the spring 16 and consequent expansion or compression of the chambers 26, 28 due to shocks emparted to the device 10. The fluid contained in the chambers 26, 28 and transmitted through the path 30 comprises a conventional hydraulic fluid. It should be noted that the chambers 26, 28 are sealed against the outer housing such that fluid may only be contained in the chambers 26, 28 or the path 30. Damping of structural agitation by restricted flow of a fluid in association with an elastomeric shear spring is particularly successful against low frequency, high amplitude shocks to the device 10.

The spring 16 also includes voids 32 which facilitate the elastic deformation of the spring.

It is a feature of the invention that a pressure relief means is disposed in the housing 12 for association with the fluid chambers for the selective relief of pressure formed in the chamber by structural agitation. Such selective relief decouples the high frequency dynamic agitation to improve the high frequency performance of the mount. More particularly, the pressure relief means comprises a recess or void 40, 42 in the rigid housing side wall portion 44 which is sandwiched by an elastomeric inner wall coating 46 and a rigid outer sleeve 48. Adjacent the recesses 40, 42 the coating 46 comprises an elastomeric diaphragm which can deform into the recess but is restrained against excessive deformation by the outer sleeve 48. Typically coating 46 is bonded to housing 12.

In operation, the coating 46 essentially separates the fluid chambers 26, 28 from an associated pair of air or gas chambers comprising the recesses 40, 42. The coating 46 operates as a diaphragm which is allowed to move with the fluid for small amplitude structural agitation to the mount 10, or motions of the mount 10 before restrainment of the diaphragm for larger motions. More particularly, small oscillations such as low amplitude structural shocks deflect the coating 46 into the recesses 40, 42 to a lesser extent so that the coating does not contact the outer sleeve restraint stop 48. As a result, very little pressure is developed within the fluid chambers to cause a damping operation. For larger amplitudes, the coating 46 will deform to the extent to contact the outer sleeve restraint. Once the outer sleeve is contacted, pressure is developed quickly in the fluid and the chambers 26, 28. This rise in pressure then activates either a tuned fluid resonance channel or a simple restriction orifice or path as shown. With particular reference to FIGURE 3 it should be noted that the mount 10 is aligned preferably so that vibration and agitation occurs in a direction substantially aligned from recess to recess, or, in other words, from fluid chamber to fluid chamber, as generally indicated by the arrows illustrated within the rigid inner member 14.

With particular reference to FIGURE 4, an alternative embodiment of the invention is shown. For ease of understanding, like elements in the device shown in FIGURE 4 to the device of FIGURES 1 -3 are illustrated with a like numeral with a primed suffix and new elements are identified by new numerals. In this embodiment an air chamber 54, which can be selectively pressurized, works with recess

chamber 40′ which is also selectively pressurizable so that the damping response of the mount 10′ can be adjusted for selective operational response. The feature provides for an active damping device. The pressurizing of the device being by conventional means is known in the art. In operation, fluid chamber 56 communicates with generally opposite fluid chambers 58, 60 through restricted fluid flow paths 62, 64 disposed about the periphery of elastomeric shear spring 66. Diaphragm 46′ and outer sleeve 48′ sandwich the recess 40′ in the housing sidewall 44′. The outer sleeve 48′ similarly provides a restraining stop against deflection of the diaphragm 46′ into the recess 40′.

It is within the scope of the invention to provide a pressure relief recess in a wide variety of shapes or configurations. In addition, the coating diaphragm itself may alternately comprise a wide variety of configuration and shapes such as support plates with restrictive orifices, elastomers including a wire mesh or screen, and rigid walls or fabric molded into the coating material.

The invention has been described with reference to a preferred and alternative embodiment. Obviously, modifications and alterations will occur to others upon a reading and understanding of this specification. It is our intention to include all such modifications and alterations insofar as they come within the scope of the appended claims or the equivalents thereof.

1. An elastomeric damping device for load carrying and dampening of structural agitation comprising:

a rigid outer housing and a rigid inner member;

an elastomeric shear spring spacing the housing from the inner member and having a fluid chamber, containing a fluid, said chamber further having a restricted flow path; and,

pressure relief means disposed in said housing for association with the fluid chamber for selective relief of pressure formed in the chamber by the structural agitation.

2. The damping device as claimed in Claim 1 wherein said pressure relief means comprises a recessable wall portion of the housing.

3. The damping device of Claim 2 wherein the rigid outer housing has an inner wall coating comprising an elastomeric material and a recessed air chamber adjacent the fluid chamber, the coating adjacent the recess comprising the recessable wall portion.

4. The damping device of Claim 3 wherein the housing includes a rigid outer sleeve, the sleeve being disposed in a covering association with the recess and comprising a restraint limit for the recessable wall portion.

5. The damping device of Claim 4 wherein recessed air chamber operatively works with a second air chamber to allow for selective operational response.

6. A fluid filled engine mount comprising:

a rigid housing including a side wall void having a rigid outer void wall and a recessable inner void wall, an elastomeric shear spring received within the housing including a fluid containing chamber adjacent the side wall void and having a restricted fluid flow path; and,

a rigid inner support member whereby small movement of the mount is allowed by deflection of the elastomeric inner void wall without incurring damping or high dynamic spring rates for improved high frequency performance.

7. The engine mount as defined in Claim 6 wherein said inner void wall comprises an elastomeric diaphragm.

8. The engine mount as defined in Claim 6 wherein said inner void wall comprises an elastomeric sleeve.

9. The engine mount as defined in Claim 6 wherein said void comprises an annular recess.

10. The engine mount as defined in Claim 6 wherein said fluid chamber comprises a pair of oppositely spaced fluid chambers in fluid communication by the restricted flow path, each of the pair being associated with one of a pair of contiguous recessable inner void walls.

11. The device substantially as described herein with reference to the accompanying drawings.

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